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10/696,591	10/28/2003	Marko Vehkamaki	SEPP24.004AUS	7184

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EXAMINER

TUROC, DAVID P

ART UNIT	PAPER NUMBER
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1762

DATE MAILED: 08/11/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/696,591	VEHKAMAKI ET AL.	
	Examiner	Art Unit	
	Kelly Stouffer	1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 October 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20, 22-33 is/are rejected.
- 7) ☒ Claim(s) 21 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>28 October 2003</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Specification

1. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: --Process for producing bismuth-containing oxide films--.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 5, 16, and 33 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter that was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In claim 16 line 2 and claim 33 line 2 the second bismuth compound of the group is written "(Bi,La)₄Ti₃O₁₂". The omission of the stoichiometric subscript on Bi and replacement by a comma prevents one of ordinary skill in the art from making and using the claimed invention. The specification does not contain a written description of this compound as it is also referred to as "(Bi,La)₄Ti₃O₁₂" in line 3 of paragraph [0002].

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter, which the applicant regards as his invention.

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Claims 5, 16, and 33 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 16 line 2 and claim 33 line 2 the second bismuth compound of the group is written "(Bi,La)₄Ti₃O₁₂". The omission of the stoichiometric subscript on Bi and replacement by a comma is confusing to one of ordinary skill in the art and fails to distinctly claim the subject matter.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 6-7, 10, 22, and 24 are rejected under 35 U.S.C. 102(b) as being anticipated by Gordon et al. PCT publication WO02/27063.

Gordon et al. discloses a process for producing a bismuth-containing oxide thin film by Atomic Layer Deposition (ALD) on page 1 lines 1-3 and 23-24. The organic bismuth compound containing at least one silylamido ligand as a source material for the thin film is described in Table 1 Compound 15 on page 16. Gordon et al. meets all the recitations of claim 1, at least as broadly recited in claim 1.

With regard to claims 2 and 3, Gordon et al. shows a bismuth compound in Table 1 Compound 15 on page 16 that is a tris(bis(trialkylsilyl)amido) bismuth (III) compound

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in which each alkyl has 1 to 4 carbon atoms and each alkyl is the same at least as broadly recited in claims 2 and 3.

With regard to claims 6 and 7, Gordon et al. discloses a bismuth compound in Table 1 Compound 15 on page 16 that has 3 silylamido ligands with the form – $N(SR^1R^2R^3)_2$ where R^1 , R^2 , and R^3 are methyl groups, methyl being a linear C_1 - C_{20} alkyl. Gordon et al. meets all the recitations of claims 6 and 7, at least as broadly recited in claims 6 and 7.

With regard to claim 10, Gordon et al. discloses a method for producing a bismuth-containing oxide thin film on a substrate by Atomic Layer Deposition (ALD) on page 1 lines 1-3 and 23-24. The organic bismuth compound containing at least one silylamido ligand as a source material for the thin film is described in Table 1 Compound 15 on page 16. The source material is fed in to a reaction space, or heated deposition chamber 110 in Figure 1, in the vapor phase, or reactant vapor 30 in Figure 1. The applicant claims that an oxygen source material capable of forming an oxide with the bismuth source material is pumped into the reaction space. Gordon et al. discloses in pages 9-10 lines 19-22 and 1, respectively, that water vapor or an alcohol is pumped alternately to the vapor of the bismuth source material to act as the oxygen source in reaction chamber 110 (Figure 1) as described on page 24 lines 3-6 and pages 28-29 lines 23-25 and 1-17, respectively. Gordon et al. meets all the recitations of claim 10, at least as broadly recited in claim 10.

Claim 22 discloses the oxygen source to be one of water, oxygen, hydrogen peroxide, et seq. Gordon et al. discloses the oxygen source material to be water or

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alcohol on pages 9-10 lines 19-22. Gordon et al. meets all the recitations of claim 22, at least as broadly recited in claim 22.

With regard to claim 24, Gordon et al. discloses on page 29 lines 18-20 the vapor phase pulse of the organic bismuth compound is mixed with a carrier gas when fed into deposition chamber 110 in Figure 1, also known as reaction space. Gordon et al. meets all the recitations of claim 24, at least as broadly recited in claim 24.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 4, 8, 9, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gordon et al. With regard to claims 4, 8, and 9 Gordon et al. is described in paragraph 4 above and includes a method for making bismuth oxide thin films with a bismuth metal source with ligands that include a silylamide group with 3

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attached groups "R". Gordon et al. does not disclose the "R" groups on the silylamide as being different, or as an aryl, phenyl, alkylaryl, or halogenated carbocyclic group. Claims 4, 8, and 9 of the applicant require that the "R" groups attached to the silylamide ligand of the bismuth are either different, an aryl carbocyclic group, or an alkylaryl, or halogenated carbocyclic group, respectively. The bismuth silylamide compound with any of these "R" groups will have a similar structure to the bismuth silylamide compound disclosed by Gordon et al. in Table 1 Compound 16 with methyl as the 3 "R" groups. See *In re Payne*, 606 F.2d 303, 313, 203 USPQ 245, 254 (CCPA 1979), *In re Papesch*, 315 F.2d 381, 137 USPQ 43 (CCPA 1963), and *In re Dillon*, 919 F.2d 688, 16 USPQ2d 1897 (Fed. Cir. 1991).

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to include a bismuth silylamide complex with "R" groups that are different, or an aryl, phenyl, alkylaryl, or halogenated carbocyclic group because these compounds have the same basic structure as the compound taught by Gordon et al. and hence would have similar properties. As such, one would reasonably expect use of these structurally similar compounds to be operable as precursors for forming the bismuth oxide films.

With regard to claim 23, Gordon et al. includes a carrier gas that is used to speed the flow of reactants in the reaction chamber and purge reaction byproducts and un-reacted reactant vapor on page 29 lines 18-20. Gordon et al. does not explicitly state that the inert gas is used to purge the reactant byproducts in between pulses, though one of ordinary skill in the art would realize it is implicitly stated.

It would be obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to explicitly state that the inert gas flows in between pulses of reactants in order to purge reaction byproducts and un-reacted reactant vapor.

Claims 5, 11-14, 15-20, 25-27 and 31-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gordon et al. in view of US Patent number 6177135 to Hintermaier et al. For claims 5, 13, 16, and 33 Gordon et al. is described in paragraph 4 above and includes tris(bis(trimethylsilyl)amido bismuth (III) compounds. Gordon et al. does not specify the structure of the oxide films. Hintermaier et al. teaches in column 6 lines 55-63 that the ternary or multicomponent oxide films could have various structures, including $(\text{Bi}_2\text{O}_2)(\text{Bi}_2\text{Ti}_3\text{O}_{10})$ and the bismuth compounds could be a tris(bis(trimethylsilyl)amido bismuth (III) compound in column 6 lines 33-37. Hintermaier et al. also teaches that these films are useful in forming non-volatile memories due to their ferroelectric properties in column 1 lines 35-41 and column 6 lines 63-66.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to include the structure of the multicomponent or ternary oxide films as $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ and the use of tris(bis(trimethylsilyl)amido bismuth (III) compounds as taught by Hintermaier et al. in order to provide oxide films having ferroelectric properties which are useful for forming non-volatile memory devices.

With regard to claims 11, 14, 19-20 and 26-27 Gordon et al. includes a method for producing a bismuth-containing oxide thin film on a substrate by Atomic Layer Deposition (ALD) on page 1 lines 1-3 and 23-24. Gordon et al. includes the product of

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the feeding and pulsing of gases that may be described as ternary or multicomponent on page 3 lines 18-19 and page 10 lines 2-5 with more than one source material to form more than one oxide. The source materials are fed in to a reaction space, or heated deposition chamber 110 in Figure 1, in the vapor phase, or reactant vapor 30 in Figure 1. The applicant claims that an oxygen source material capable of forming an oxide with the bismuth source material is pumped into the reaction space. Gordon et al. discloses on page 9 lines 19-21 that water vapor or an alcohol is pumped alternately to the vapor of the bismuth source material to act as the oxygen source in reaction chamber 110 (Figure 1) as described on page 24 lines 3-6 and pages 28 and 29 lines 23-25 and 1-17. Gordon et al. describes the vapor pulses in the order of first source material, second source material, and oxygen source material as alternating on page 9 lines 19-21. The organic bismuth compound containing at least one silylamido ligand as a source material for the thin film is described in Table 1 Compound 15 on page 16. The second metal source material can be at least any other metal, including volatile main-group metals and transition metals from Table 1 as described on page 10 line 1. The second metal source is comprised as one or more reactants from containing groups 1-14 of a periodic table as shown in Table 1. Gordon et al. also includes that metal alkyls, or metal organic compounds in Table 2 and metal halides may be used in the practice of the invention on page 20 lines 6-8 and page 23 lines 2-4, respectively. Gordon et al. also discloses that metal or metalloid alkoxy compounds may also be useful on page 22 lines 9-11. Alkyl amino compounds for use in the invention are described in Table 1. Gordon does not explicitly disclose combining a bismuth

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compound with a silylamido ligand with at least a second metal precursor to form a Bi-containing multicomponent oxide as required in claims 11, 14, 19-20, and 26-27.

Hintermaier et al. teaches forming Bi-containing multicomponent oxides from a Bi compound with a silylamido ligand and a second metal precursor in column 6 lines 25-32 and 55-67 in order to make oxide films with ferroelectric properties that can be used in non-volatile memory devices as discussed above. One would have been motivated to make these films using ALD given the advantages for ALD over CVD taught by Gordon et al. on page 1.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to specify the first metal material as the Bi containing silylamide compound he discloses in Table 1 Compound 16 and the second metal source material as one of the compounds disclosed belonging to the groups 1-14 of the periodic table, halides, metal organic compounds, alkoxies, or alkylaminos in order to provide oxide films having ferroelectric properties which are useful for forming non-volatile memory devices.

With regard to claims 12 and 15 Gordon et al. include a process for making ternary and multicomponent thin films using a bismuth metal source with at least one silylamide ligand and another metal. Gordon et al. does not include the second metal source as an oxide of copper, titanium, tantalum, calcium or strontium. Hintermaier et al. teaches Bi containing multicomponent oxides containing metals such as Sr, Ta, and Ti are useful for their ferroelectric properties as established above and in column 2 lines 62-66.

It would have been obvious to one of ordinary skill in the art at the time of invention to include Sr, Ta, and/or Ti precursors as the second metal source in the ALD process of Gordon et al. because to do so would have reasonably been expected to provide the desirable ferroelectric Bi-containing multicomponent oxides useful in non-volatile memory devices.

With regard to claims 17 and 18 Gordon et al. includes a method for making bismuth oxide thin films that are deposited on a substrate. Gordon et al. does not specify the temperature of the substrate. Hintermaier et al. teaches the substrate temperature to be below 400 °C in order to control the decomposition mechanism of the bismuth amides on the substrate in column 6 lines 10-16.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to include the temperature of the substrate as less than 250 °C or 150-220 °C as taught by Hintermaier et al. in order to control the mechanism of the surface reaction to be a favorable decomposition mechanism of the bismuth amides and subsequent deposition of bismuth oxides.

With regard to claims 25 and 31-32 Gordon et al. includes a method for making bismuth oxide thin films with an additional metal oxide in the film. Gordon et al. also includes an organic bismuth compound with at least one bis(trialkylsilyl)amido ligand that may be combined with a second metal source material and oxygen source material by ALD by feeding alternate pulses of the reactants in to the reaction space to form a multicomponent oxide film. Gordon et al. does not anneal the two oxides together to create a ferroelectric phase. Hintermaier et al. teaches that more than one metal oxide

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can be annealed together to create a ferroelectric phase in column 6 lines 25-33 and 63-67 that will be in the presence of an oxygen-containing gas due to oxidizers used such as H_2O_2 .

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. to include annealing two metal oxides together in the presence of oxygen to form a ferroelectric phase as taught by Hintermaier et al. in order to make a film with ferroelectric properties and a ferroelectric phase that will be useful in non-volatile memory devices as discussed above.

Claims 28-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gordon et al. in view of Hintermaier et al. as applied above, and further in view of US Patent Application Publication 2003/0124875 to Kil. Gordon et al. and Hintermaier et al. are described above and include vapor pulses of two metal sources and an oxygen source to deposit a multicomponent oxide by ALD. Gordon et al. and Hintermaier et al. do not explicitly disclose including an oxygen pulse in between each vapor pulse of a metal source. Kil teaches an ALD process for forming multicomponent oxide films comprising alternating a pulse of each vapor source with a pulse of the oxygen source material in column 2 lines 1-18 to allow precise control of the composition of the multicomponent oxide film without changing the feeding ratios of the vapor sources as described in column 3 lines 26-33.

It would have been obvious to one of ordinary skill in the art at the time of invention to modify Gordon et al. and Hintermaier et al. to include an oxygen pulse in

between each vapor pulse of a metal source as taught by Kil in order to allow precise control of the composition of the multicomponent oxide film without changing the feeding ratios of the vapor sources.

With regard to claims 29 and 30, Gordon et al. includes two metal sources and an oxygen source pulse including a bismuth compound with a silylamide ligand that will be deposited on a substrate by ALD to form a multicomponent or ternary metal oxide film. Gordon et al. does not include any ratios of the bismuth metal source cycle to the second metal source cycle or the stoichiometric surplus ratio of bismuth oxide to the second metal oxide in the film. Claims 29 and 30 of the applicant require that the ratio of bismuth precursor cycles to second metal source cycles is from 10:1 to 1:10 or 6:1 to about 1.5:1 and the multicomponent oxide film has a stoichiometric surplus of 1 to 20 atomic percentage of bismuth. The parameters of bismuth to second metal cycle ratio and stoichiometric percentage of bismuth in the film are related because the more times each source is pulsed, the larger the percentage of that source's oxide will be in the film according to Gordon et al. in column 21 lines 21-40. The parameters of bismuth to second metal cycle ratio and stoichiometric percentage of bismuth in the film are result effective variables as stated by Hintermaier et al. in column 3 lines 43-36 to depend upon the particular apparatus and conditions employed in carrying out the method and the importance of these parameters is that they are sufficient to deposit a layer of multicomponent oxide of predictable composition. The optimizations of these two parameters are by routine experimentation and are not inventive. (See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 234 (CCPA 1955))

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Gordon et al. to include the ratio of bismuth precursor cycles to second metal source cycles is from 10:1 to 1:10 or 6:1 to about 1.5:1 and the multicomponent oxide film has a stoichiometric surplus of 1 to 20 atomic percentage of bismuth through routine experimentation in order to deposit a multicomponent oxide of a certain composition under particular apparatuses and conditions especially absent evidence showing a criticality for using the claimed bismuth to second metal cycle ratio and stoichiometric percentage of bismuth in the film.

Allowable Subject Matter

Claim 21 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 21 requires that a second metal source material in a Bi-containing multicomponent film comprises a double metal precursor where each molecule contains two metals in a discrete ratio.

Gordon et al, described above, includes multicomponent oxide films that may include bismuth and another metal source. The second metal source disclosed in Gordon et al. in Tables 1, 2, and 3 does not comprise a double metal precursor as required by claim 21.

Hintermaier et al, described above, includes Bi-containing multicomponent oxide films with a second metal source. The second metal source described in column 3 lines 5-32 does not comprise a double metal precursor as required by claim 21.

Gordon et al. and Hintermaier et al. do not meet the requirement of a double metal precursor in claim 21, alone or in combination.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Sasaki shows a method for depositing bismuth-containing oxide films

Glassman et al. shows a method for forming bismuth-containing films

Cho et al. shows a method for depositing bismuth-containing oxide films

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kelly Stouffer whose telephone number is (571) 272-2668. The examiner can normally be reached on Monday - Friday 7:00-3:30.

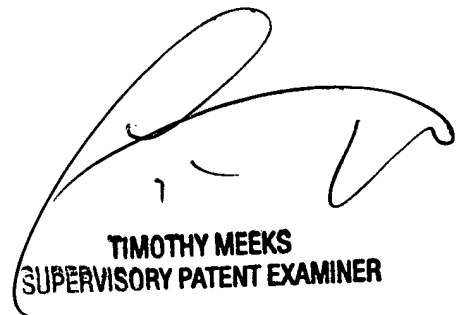
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Kelly M. Stouffer
Examiner
Art Unit 1762

kms



TIMOTHY MEEKS
SUPERVISORY PATENT EXAMINER